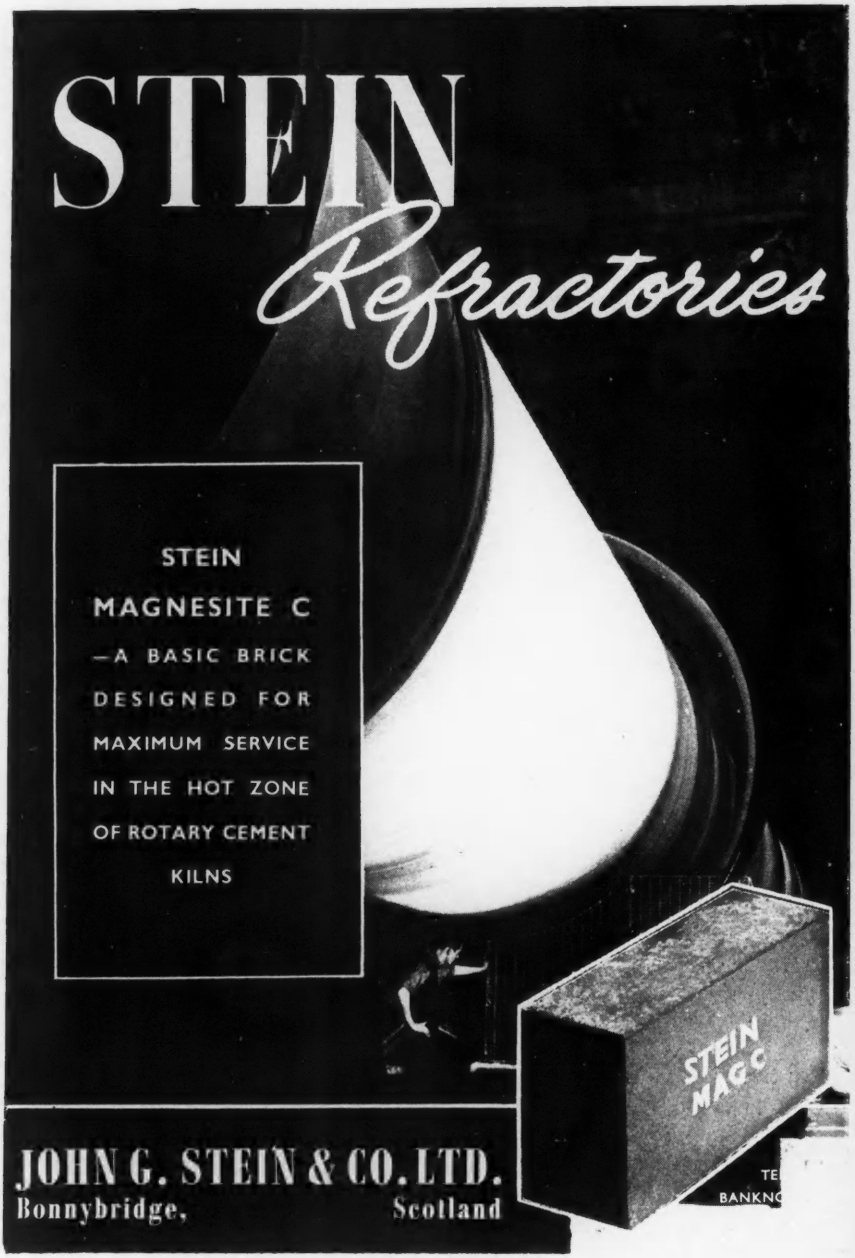
CEMENT AND LIME MANUFACTURE

XXXII. No. 3 MAY, 1959 Price 1s. 2d. Annual subscription 7s. ($1.30 in Canada and U.S.A.)

PUBLISHED BY CONCRETE PUBLICATIONS LTD., 14 DARTMOUTH STREET, LONDON, S.W.1



STEIN
Refractories
STEIN
MAGNESITE C
—A BASIC BRICK
DESIGNED FOR
MAXIMUM SERVICE
IN THE HOT ZONE
OF ROTARY CEMENT
KILNS
STEIN
MAG C
JOHN G. STEIN & CO. LTD.
Bonnybridge, Scotland

NORTON
grinding media

SUPPLIED
IN

PRIORFIELDS FOUNDRY CO. LTD

ETTINGSHALL WOLVERHAMPTON

TELEPHONE: BILSTON 41961-3

London Office : Stafford House, Norfolk Street, W.C.2. Telephone : Temple Bar 0681

Manchester Office: 331 Corn Exchange Building, Hanging Ditch, 4. Telephone: Blackfriars 9784

BRANCH OF NORTON INDUSTRIES LIMITED

Alite

SUPER REFRACTORIES

for

CEMENT & LIME WORKS

High Alumina bricks and special shapes for Rotary and Shaft kilns. Full details available on request.

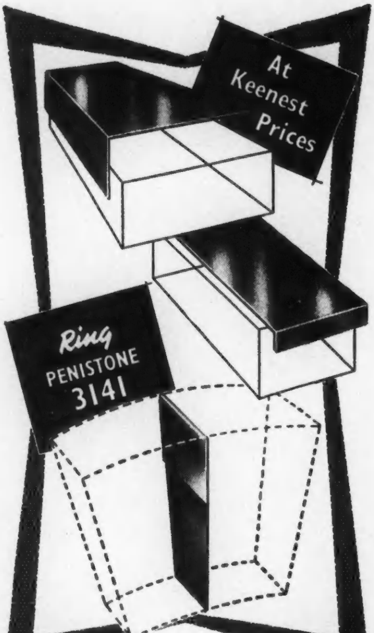
Alite	Alumina	Refractoriness
No. 1	69-72%	CONE 37-38
B. 1	62-64%	36
B.	57-59%	36
D.	39-42%	33

High-temperature Insulating Bricks.
"PEER" Air-setting Refractory Cements.
"R" Quality Fire brick for lower temperature work and resistance to abrasion.

EJ&JP

E. J. & J. PEARSON LIMITED
STOURBRIDGE, ENGLAND

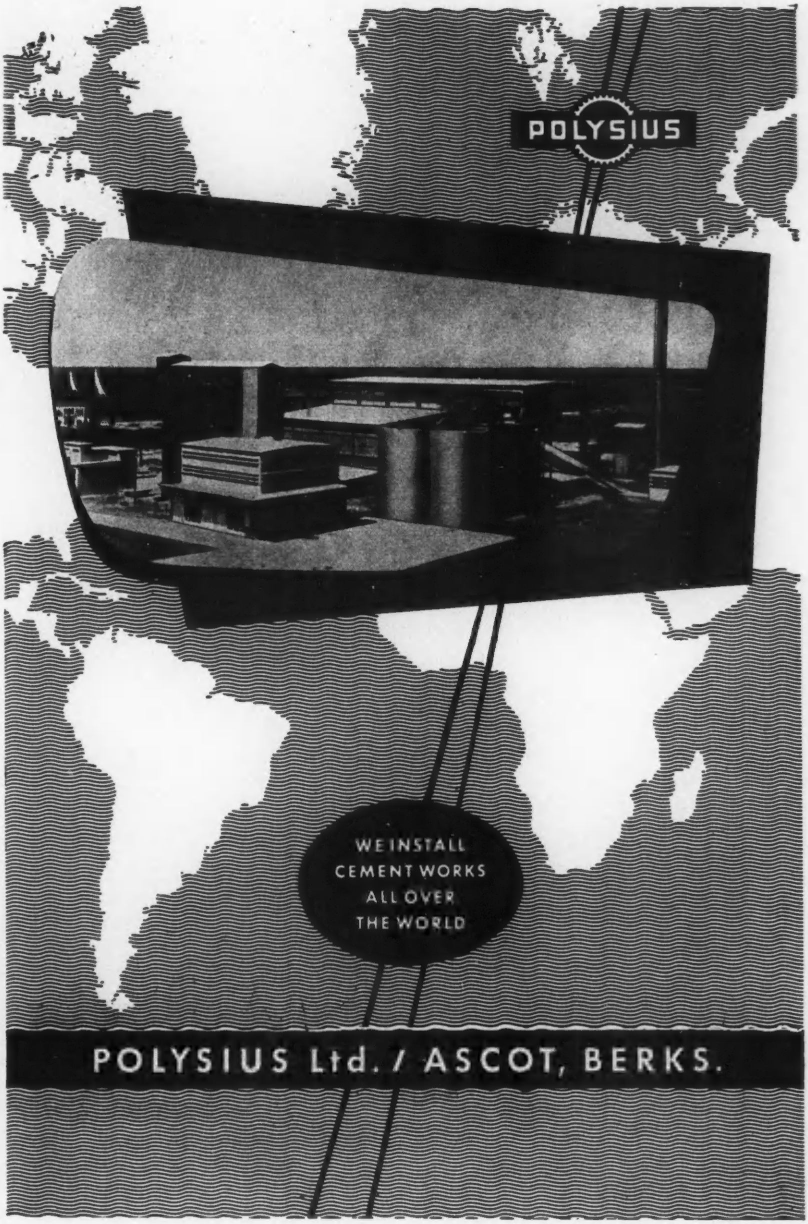
STEEL
JOINTING SHEETS
for BASIC BRICKS



Produced in Sheet Steel in all thicknesses from 21 gauge to $\frac{1}{8}''$. For easy handling, all products are packed in bundles of 25 or 50 according to weight, and marked to customer's specification.

SOLE MANUFACTURERS TO THE CHROME-MAGNESITE BRICKMAKERS ASSOCIATION

FLOUCH GARAGE and ENGINEERING CO
HAZLEHEAD near SHEFFIELD YORKSHIRE


POLYSIUS
WE INSTALL
CEMENT WORKS
ALL OVER
THE WORLD
POLYSIUS Ltd. / ASCOT, BERKS.

CEMENT AND LIME MANUFACTURE

PUBLISHED ALTERNATE MONTHS. PRICE 1s. 2d. A COPY ANNUAL SUBSCRIPTION 7s. POST FREE $1.30 IN CANADA AND U.S.A

PUBLISHED BY
CONCRETE PUBLICATIONS LIMITED
14 DARTMOUTH STREET, LONDON, S.W.1

TELEPHONE: WHITEHALL 4581.
TELEGRAPHIC ADDRESS:
CONCRETIUS, PARL. LONDON.

PUBLISHERS OF
"CONCRETE & CONSTRUCTIONAL ENGINEERING"
"CONCRETE BUILDING & CONCRETE PRODUCTS"
"CEMENT & LIME MANUFACTURE"
"THE CONCRETE YEAR BOOK"
"CONCRETE SERIES" BOOKS.

VOLUME XXXII. NUMBER 3. MAY, 1959

An Accelerated Test of the Strength of Cement.

In connection with the building of large dams in Switzerland a method was required of estimating accurately, within 48 hours, the compressive strength of cement at 28 days. A new test to this end was devised in the Swiss Federal Laboratory for Testing Materials and Research where, and at seven other laboratories, tests were made of more than 700 specimens of eleven brands of Swiss Portland cement. The following notes are abstracted from a report issued by the Laboratory as a result of these tests.

When mortar prisms were made in accordance with the Swiss standards for Portland cement and treated as follows it was found that their compressive strengths at very early ages were nearly equal to those of similar prisms cured in water for 28 days. Immediately after casting the prisms were stored for twenty-four hours in air at a temperature of 18 deg. C. (64·4 deg. Fahr.) and a relative humidity of 95 per cent. They were then placed in an autoclave and covered with water to a level about 4 cm. (1½ in.) above the specimens. The autoclave was closed, the bottom heating elements switched on, and the steam outlet opened until steam escaped freely about one hour later. The steam outlet was then closed and the side heating switched on until a pressure of 12 atmospheres was reached about one hour later. This pressure was maintained for three hours by automatic controls allowing a variation between 11.5 and 12 atmospheres. Heating was then stopped, the steam outlet opened, and the system was allowed to cool for about three hours until a temperature of about 90 deg. C. (197 deg. Fahr.) was reached. The water was then drawn off and the specimens were removed and placed in hot water to cool to room temperature in about one hour.

The autoclave used by the Federal Laboratory had a diameter of 36 cm. (14·2 in.) and an average depth of 48 cm. (19 in.). An 8 kW. heater was used, one-third of the element being at the bottom and two-thirds at the sides. The heating was controlled by pressure and a thermometer. Similar autoclaves were

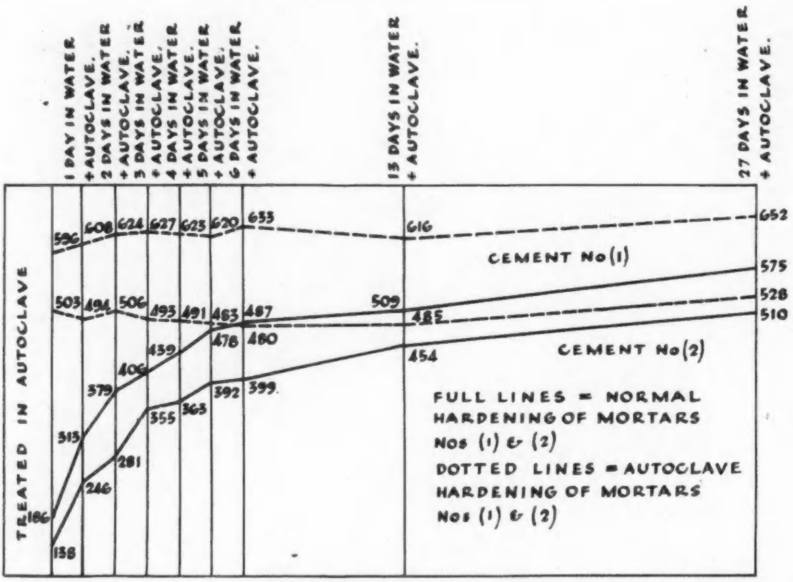


Fig. 1.—Comparison of the Strengths (Kg. per square centimetre) of Standard Specimens and Specimens stored in Water for various Periods up to 27 days before Treatment in the Autoclave.

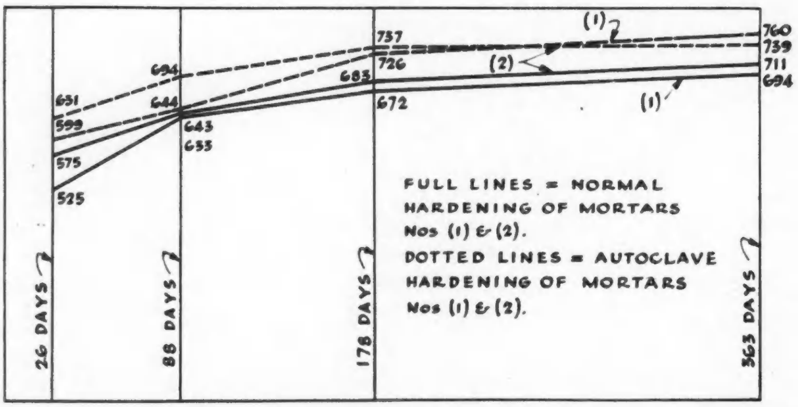


Fig. 2.—Comparison of the Strengths (Kg. per square centimetre) of Standard Specimens and Specimens treated in the Autoclave after storing in Water for Periods up to One Year.

used at six other laboratories and at one a U.S.A. Cenco autoclave was used, and all the results were similar as is shown by the selection of the results with six brands of cement given in *Table* 1.

These experiments showed that the accelerated test gives an early indication of the strength in compression to be expected at twenty-eight days, but this is not so in the case of the strength in bending, which in the accelerated test usually increased less than the compressive strength. In the very few cases (1·6 per cent.) when the specimens prepared in the autoclave were unsuitable for testing similar specimens also failed in the Le Chatelier and cement-pat tests. In these specimens there was a low stability of lime, so that the autoclave test is also an indication of the constancy of volume of the cement. Investigation of the effects of differences in fineness of the cement and higher contents of MgO and

TABLE No. 1.

Cement	Laboratory	No. of tests	28 days' Standard Test Max. (Kg. per sq.cm.)	Min.	Average	Autoclave Test Max. (Kg. per sq.cm.)	Min.	Average†
No. 1	(a)	58	643	467	554	642	467	574
	(b)	58	548	442	505	610	425	493
	(c)	13	609	484	555	580	521	544
Average		128	600	464	538	611	471	537
No. 2	(a)	57	571	481	534	611	251*	567
	(b)	57	555	440	493	550	475 432	467
	(c)	14	577	526	546	567	183* 401	529
Average		128	568	482	524	576	436	521

* Minimum values of tests that failed. † Excluding tests that failed.

CaO showed that, provided that the limits set by the Swiss standards were not exceeded, the results of the accelerated tests were not affected, except that when about 3 per cent. of free CaO was present low results were, with one exception, coupled with a low constancy of volume.

It was established that in the accelerated tests some components of the clinker underwent abnormal reactions and that a secondary reaction took place between the quartz grains and the $Ca(OH)_2$ arising after setting, and this no doubt increased the strength of the specimen hardened in the autoclave. A comparison of results of accelerated and normal tests (*Fig.* 1) shows that whether the autoclave treatment follows storage in moist air for twenty-four hours or in water up to twenty-seven days a reliable indication is given of the compressive strength at twenty-eight days. A similar comparison shown in *Fig.* 2 indicates that, whether they are hardened normally or in an autoclave, the further increase of strength of the specimens when stored in water for any time up to one year was almost equal. Thus the process of the development of strength of standard mortar after treatment in the autoclave is very similar to that of mortar hardened normally for twenty-eight days.

Reaction of Portland Cement with Water.

THE analysis of the intergranular solution from gauged cement can provide useful information, and in " Revue des Materiaux " for October, 1958, A. R. Steinherz and N. Welcman describe the results of some of their investigations.

For experiments on the effect of the type of cement on the reaction with water, three types of cement were used having the following percentage composition: Cement A: C_3S, 53·9; C_2S, 20·2; C_3A, 12·6; C_4AF, 10·7. Cement B: C_3S, 49·8; C_2S, 20·6; C_3A, 12·3; C_4AF, 9·0; Cement C: C_3S, 41·1; C_2S, 36·4; C_3A, 1·3; C_4AF, 14·9.

The cements were gauged with 60 per cent. of distilled water and the intergranular solution was separated in a laboratory centrifuge one minute after gauging. The water which separated (between 25 and 40 per cent. of the gauging water) invariably had a pH value between 12·4 and 12·6. The concentration of calcium ions increased with decrease of C_3S. The concentration of sulphate ions always exceeded that of calcium ions, probably due to reaction of the alkalis with gypsum. The concentrations of the alkalis in the solutions followed the order of their content in the original clinker.

To determine the effect of the sizes of the particles of cement, ground clinker A was divided into portions above and below 20μ by sedimentation in absolute alcohol, using 0·1 per cent. of calcium chloride as anticoagulant which was subsequently removed by washing with absolute alcohol. The calculation was made according to Stokes's law. Repeated decantations were required to obtain complete separation. After the alcohol had been removed, the samples were intimately mixed with 5 per cent. of finely-ground pure calcium sulphate dihydrate, thus eliminating the variation in content of gypsum usually obtained when separating fine and coarse portions of cement.

The two fractions were gauged and separated by centrifuging as before. The solutions obtained from the two fractions did not differ significantly, but the concentration of calcium ions was much greater than in the case of the original clinker A (also mixed with 5 per cent. of gypsum).

Using the fraction between 20μ and 90μ of clinker A (which had a low content of alkali), instead of adding gypsum, additions of potassium sulphate were made and the solutions were separated five minutes after gauging. The concentration of calcium ions was lowered to a constant value and the content of potassium sulphate was increased from 1 to 4 per cent., but with 5 per cent. of potassium sulphate the concentration of the calcium ion fell suddenly. There was a deficit in sulphate ions, suggesting that this had been precipitated as calcium sulphate dihydrate, using calcium ions from the hydrolytic reactions. There was also a deficit in potassium ions, suggesting that potassium hydroxide had been absorbed by hydrated gels on the particles of clinker.

Normal setting time appears to demand a concentration of calcium ion within fairly narrow limits. An addition of 3 per cent. of disodium ethylenediamine tetracetate, which " complexes " calcium, produces a marked reduction in setting time.

Television in the Cement Industry.

IT is claimed that the use of eight television cameras to observe the transport and treatment of cement raw materials from the quarry to storage at the works at Mojave of the California Portland Cement Co. is the most extensive application of this method so far made in the U.S.A. cement industry.

The operations televised are the delivery of rock by lorry to the primary crusher; delivery to the secondary crusher; transfer from the secondary crusher to a belt-conveyor; transfer from belt-conveyor to hopper; the vibrating conveyors to the primary screens; the primary screens; the secondary screens; the storage building. These operations are shown on eight 12-in. by 10-in. screens in a control room, where they can be seen by a man at a control panel. In cases where crushers and screens are in different buildings, the men operating them have inter-communicating microphones and loudspeakers. The works has five kilns and a capacity of nearly 3000 tons of cement per day.

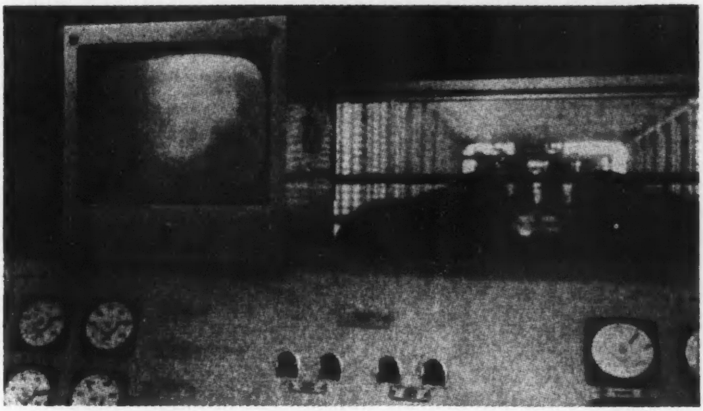


Fig. 1.—Television receiver mounted on the control panel.

At the works at New Houston, Texas, U.S.A., of the Ideal Cement Company, a closed-circuit system of television has been installed for observing the burning-zones in two rotary kilns. The kilns are 450 ft. long by 12 ft. diameter and the wet-process is used. The fuel is natural gas. The television receivers (*Fig.* 1) are in an air-conditioned room about 150 ft. from the kilns and from which the kilns can be seen. In this room are the kiln controls and the controls for the crushing of the raw materials and the grinding and storage of the cement, and all these processes are controlled by one man.

A separate camera, power supply, control panel, and receiver are installed for each kiln. The cameras are equipped with a cold cathode tube of the image-dissector type. Three hundred lines are used in the frame, and the tube is designed for the special condition. The camera is mounted on a bracket outside the kiln

about 3 ft. to one side and 1 ft. below the axis of the kiln and burner. The temperature at the end of the kiln is 2100 deg. F. The observation window is of heat-resisting glass covered with a heat-reflecting preparation. Cool dry air is blown on to both sides of the window at the rate of about 150 cu. ft. per minute, and this air escapes into the kiln. The camera is also cooled by air. The power supply and controls for each camera are in a cool place about 40 ft. from the kilns, and a supply of compressed air is kept available in case of a failure of the power supply. Controls are provided for altering the focus and the volume of the signal; variations in lighting are compensated for automatically.

The receivers are connected to the cameras by co-axial cables. They have 17-in. screens, and controls are provided for focus, contrast, brilliance, and for horizontal and vertical adjustment. The picture gives a view of the interior of the kiln from about 50 ft. from the firing end to the discharge end, so that the flow of slurry and clinker, the formation of clinker rings, local overheating, and the size of the clinker as it leaves the kiln can be seen. The system was developed in co-operation with the Diamond Power Speciality Corporation, of Lancaster, Ohio. The note on the works at New Houston is abstracted from "Rock Products" for March, 1959.

Production of Cement Abroad in 1958.

FRANCE.

During 1958, 13,400,000 tons of cement were produced in France compared with 12,500,000 tons in 1957.

BELGIUM.

About 4,056,000 tons of cement were produced in Belgium in 1958, which is about 700,000 tons less than in 1957.

MEXICO.

It is estimated that the production of cement in Mexico in the year 1958 was 3,000,000 tons, compared with 2,500,000 tons in the previous year.

CHINA.

The production of cement in China in 1958 exceeded 10,000,000 tons, which is an increase of 50 per cent. of the production in 1957.

NEW ZEALAND.

Production of cement at a new works at Westport, the sixth in the country, began late in 1958. The production of cement in New Zealand was about 570,000 tons in 1958, which is double that in 1953. Imports, which reached a record of 193,000 tons in 1953, were little more than 2,000 tons in 1958.

CANADA.

In the year 1958 the amount of cement produced in Canada was the same as in the previous year, namely 6,000,000 tons. During last year the extension of the works of the British Columbia Cement Co. at Victoria was completed at a cost of £1,070,000. The extension of the works of the Canada Cement Co. at Montreal East was also completed at a cost of about £600,000; this company also proposes to build another large cement works near Montreal.

Revised U.S.A. Standards for Cement.

THE latest standards for cement of the American Society for Testing Materials are given in " A.S.T.M. Standards on Cement," which was issued by the Society in September, 1958 (price 3·50 dollars). Particulars of some of the omissions, revisions, and additions which have been made since the previous issue of this compilation of standards in 1955 (see this journal for November, 1956) are given in the following.

Standard C189 for the determination of the soundness of cement by the boiling-water test (the pat test) is cancelled. A new Standard (C358—1958) for slag-lime cement (see page 40 of this number) is now issued. Many of the Standards now include the requirement that the relative humidity of the laboratory shall be not less than 50 per cent. Standards bearing the date of revision 1958 but in which editorial alterations only have been made are No. C91—1958 (Masonry Cement), No. C185—1958 (Air Content of Hydraulic Cement Mortar), No. C151—1958 (Autoclave Expansion of Portland Cement), No. C109—1958 (Compressive Strength of Hydraulic Cement Mortars—2-in. cube specimens), No. C305—1958 (Mechanical Mixing of Hydraulic Cement Mortars), No. C187—1958 (Normal Consistency of Hydraulic Cement), and Nos. C191—1958 and C266—1958 (Time of Setting of Hydraulic Cement by Vicat Needle and Gillmore Needles respectively).

Physical Properties.

The principal revisions to the physical requirements are as follows.

FINENESS OF PORTLAND CEMENT.—The fineness in terms of the specific surface as determined by either the turbidimeter test or air-permeability test is reduced for Portland cements of the following types: Type II (moderate sulphate resistance or moderate heat of hydration); Type IIA (as Type II but with air-entrainment); Type IV (low heat of hydration); and Type V (high sulphate resistance). The revised requirements, in square centimetres per gramme, are as follows for cements Types II, IIA, IV, and V:

Turbidimeter test.—Average (minimum), 1600; minimum of any sample, 1500.

Air-permeability test.—Average (minimum), 2800; minimum of any sample 2600.

Standard C150—1956 applies to Types II, IV and V and Standard C175—1956 to Type IIA.

PORTLAND BLASTFURNACE SLAG-CEMENT.—The requirements for additional classes of Portland blastfurnace cements are given in Standard C205—1958 (tentative), namely, Type IS-MS (moderate sulphate resistance); Type IS-A-MS (as Type IS-MS but with air-entrainment); Type IS-MH (moderate heat of hydration); Type IS-MH-MS (moderate heat of hydration and moderate sulphate resistance); Type IS-A-MH (as Type IS-MH but with air entrainment); and Type IS-A-MH-MS (as Type IS-MH-MS but with air entrainment). The physical properties of these types of Portland blastfurnace cement and of the two earlier types, namely, Type IS and IS-A (ordinary and with air entrainment respectively)

are given in Table I. The compressive strengths of the two earlier types have been revised.

Chemical Analysis of Portland Cement.

The principal revisions in the adopted and tentative Standards C114—1958 are given in the following.

INSOLUBLE RESIDUE.—The procedure for the determination of the amount of insoluble residue is as follows. To 1 gr. of the sample of cement add 25 ml. of cold water. Disperse the cement in the water and, while swirling the mixture, quickly add 5 ml. of HCl. If necessary, warm the solution gently and grind the material with the flattened end of a glass rod for a few minutes until decomposition

TABLE I.—PHYSICAL REQUIREMENTS.

	Types IS IS (MS)	Types IS-A IS-A(MS)	Types IS(MH) IS(MH-MS)	Types IS-A (MH) IS-A (MH-MS)
Fineness (alternate methods):				
Amount retained when wet-sieved on No. 325 (44-micron) sieve, max, per cent	12	12	12	12
Specific surface by air permeability apparatus, sq cm per g:				
Average value, min	3400	3400	3400	3400
Minimum value, any one sample	3200	3200	3200	3200
Soundness:				
Autoclave expansion, max, per cent	0.20	0.20	0.20	0.20
Time of setting (alternate methods):				
Gillmore test (Method C 266):				
Initial set, min, not less than	60	60	60	60
Final set, hr, not more than	10	10	10	10
Vicat test (Method C 191):				
Set, min, not less than	45	45	45	45
Set, hr, not more than	7	7	7	7
Air content of mortar, prepared and tested in accordance with Method C 185, per cent by volume	12 max	19 ± 3	12 max	19 ± 3
Compressive strength, psi:				
The compressive strength of mortar cubes, composed of 1 part cement and 2.75 parts graded standard sand, by weight, prepared and tested in accordance with Method C 109, shall be equal to or higher than the values specified for the ages indicated below:				
1 day in moist air, 2 days in water	1200	900	1000	750
1 day in moist air, 6 days in water	2100	1500	1800	1400
1 day in moist air, 27 days in water	3500	2800	3500	2800
Tensile strength, psi:[c]				
The tensile strength of mortar briquets composed of 1 part cement and 3 parts standard sand, by weight, prepared and tested in accordance with Method C 190, shall be equal to or higher than the values specified for the ages indicated below:				
1 day in moist air, 2 days in water	150	...	125	...
1 day in moist air, 6 days in water	275	...	250	...
1 day in moist air, 27 days in water	350	...	325	...
Heat of hydration:				
7 days, maximum cal per g	...	...	70	70
28 days, maximum cal per g	...	...	80	80

of the cement is complete. Dilute the solution to 50 ml. with hot water (nearly boiling) and heat the covered mixture rapidly to nearly boiling by means of a high-temperature hot plate. Then digest the covered mixture for 15 minutes at a temperature just below boiling. Filter the solution into a 400-ml. beaker and wash the beaker, paper, and residue thoroughly with hot water. (Reserve the filtrate for the sulphur trioxide determination, if required.) Transfer the filter paper and contents to the original beaker, add 100 ml. of nearly boiling NaOH solution (10 g. per litre) and digest at a temperature just below boiling for 15 minutes. During the digestion, occasionally stir the mixture and attempt to macerate the filter paper. Acidify the solution with HCl, using methyl red as the indicator, and add an excess of 4 or 5 drops of HCl. Filter and wash the residue at least fourteen times with hot NH_4NO_3 solution (20 g. per litre), washing the entire filter paper and contents during each washing. Ignite the residue in a tared crucible at 900 to 1,000 deg. C., cool in a desiccator, and weigh. Calculate the percentage of the insoluble residue to the nearest 0·01 by multiplying the weight in grammes of the residue by 100.

FREE CALCIUM OXIDE.—A tentative method of determining the amount of free calcium oxide in Portland cement clinker and the finished cement is based on the solution of free calcium oxide in a hot solution of glycerol and alcohol, and the subsequent titration of the dissolved lime with an alcoholic solution of ammonium acetate. The apparatus, reagents, procedure of test, and method of calculating the result are described. An optional method is also described and is similar to the foregoing except that an accelerator is used in the extraction solvent to hasten the solution of the free calcium oxide.

Air-Entraining Compounds.

The requirements of the "reference addition" used in the test to determine the effect of a proposed air-entraining compound have been revised and in Standard C226-1958 (tentative), "Air-entraining Additions for Use in the Manufacture of Air-entraining Portland Cement," are now as follows. The reference addition used in the concrete mixture from which specimens will be made for tests for resistance to freezing and thawing shall be Vinsol resin, Darex, N-TAIR, or Airalon. If no material is designated, Vinsol resin shall be used. The Vinsol resin used shall be neutralised with 15 per cent. by weight of sodium hydroxide. The air contents of the concrete containing the addition and the concrete containing the proposed addition shall agree within 0·5 per cent.

The standard reference solution is prepared by placing 50 g. (total solids in the case of solutions or pastes) of the designated material in 500 ml. of freshly-distilled water in a 1000-l. flask and mixing thoroughly until the solids are completely dissolved or the paste or solution is uniformly diluted. After surface foam has been dissipated, dilute to 1000 l. and mix thoroughly. With Vinsol resin the neutralised solution shall be made by dissolving 7·50 g. of cp. sodium hydroxide (NaOH) in 100 ml. of distilled water. Add a few drops of this solution to 300 to 350 ml. of distilled water contained in a 600-ml. beaker. Add 50 g. of dry unneutralised

Vinsol resin in pulverised form to the beaker and stir until all of the resin is wetted and well dispersed. Then add all the sodium hydroxide solution to this suspension and stir until all of the resin is in solution. Transfer to a measuring flask, dilute to 1000 l. and mix thoroughly. From this stock standard solution prepare a dilute standard solution by diluting 100 ml. of the stock solution to 1000 l.

For comparative tests of cement with and without air entrainment, the quantity of the sample of cement shall be not less than eight standard bags (each containing 94lb.) for cement containing the proposed addition and not less than ten bags of the corresponding control cement. If direct comparisons of compressive and bending strength, bond (to steel), " bleeding ", and change of volume are required for cements containing the proposed and reference addition, the quantity of control cement shall be increased to 16 bags.

Six specimens of concrete are now required for each condition of the concrete to be tested.

Slag-Lime Cement.

The specification of the American Society for Testing Materials for " Slag Cement " (No. C. 358-58), which has been issued hitherto tentatively, has now been revised and issued as a standard specification. The principal requirements are given in the following. There are two types of slag cement, which consists of granulated blast-furnace slag and hydrated lime. Type S is for blending with Portland cement for making concrete or for blending with hydrated lime for making masonry mortar. Type SA is for similar purposes but is air-entraining.

Slag cement shall consist of at least 60 per cent. by weight of water-quenched blastfurnace slag. Water or untreated calcium sulphate or both may be added in amounts such that the specified amount of sulphur trioxide and the loss on ignition are not exceeded. For air-entraining slag cement an addition complying with the requirements of the Specifications for Air-entraining Additions (C.226) shall be used.

The percentages of chemical constituents shall not exceed the following: Sulphur trioxide (SO_3), 4·0; magnesium oxide (MgO), 5·0; manganic oxide (Mn_2O_3), 1·5; sulphide sulphur (S), 2·0; insoluble residue, 1·0; and loss on ignition 4·0.

The composition of blast furnace slag shall conform to the following:

$$\frac{CaO + MgO + \frac{1}{3}Al_2O_3}{SiO_2 + \frac{2}{3}Al_2O_3} \text{ not less than } 1{\cdot}0.$$

The physical properties of the cement shall conform to the following. Specific surface: Average, 4700 sq. cm. per gramme; minimum, 4200 sq. cm. per gramme. Autoclave expansion or contraction, 0·5 per cent. Initial set, 45 minutes. Final set, 24 hours. Air content of mortar (Method C.185): Type S, 12 per cent. (maximum) by volume; Type SA, 19 per cent. by volume. Compressive strength of mortar cubes (lb. per sq. in.)—1 day in moist air, 6 days in water: 600 (Type S), 500 (Type SA); 1 day in moist air, 27 days in water: 1500 (Type S), 1000 (Type SA).

The manufacturer shall state the source, amount, and composition of the granulated blastfurnace slag used in the finished cement and the proportions of

slag and lime in the slag cement. The composition of the slag cement shall conform to that shown in the statement of the manufacturer within the following tolerances: Silicon dioxide (SiO_2), 3 per cent.; aluminium oxide (Al_2O_3), 2 per cent.; calcium oxide (CaO), 3 per cent.

Delivery of Loose Cement by Rail and Road.

THE Scottish Region of British Railways, the contractors (Messrs. John Mowlem & Co., Ltd.) and the cement makers (Clyde Portland Cement Co., Ltd.) have collaborated in arrangements for supplying cement to the nuclear power station in course of construction at Hunterston. The silos, the weighbridge, and the compressor shown in *Fig.* 1 have been erected by British Railways at West Kilbride station, which is three miles from the site of the power station and a special railway wagon, which is shown in *Fig.* 2 has been built.

The objective is to meet the varying requirements of the work without disturbance to other railway traffic. Between 30,000 and 40,000 tons of cement will be used in the construction of the power station, and the daily requirements depend on the weather and the stage of concrete construction. Deliveries also have to be made continuously to many different parts of the site, and road vehicles owned by the cement makers are used to take the cement from the railway station to the site, a distance of three miles.

The loose cement is loaded at the factory into air-discharge railway wagons with a capacity of 90 tons by means of a portable Diesel compressor-pump at the rate of one ton per minute, and the empty wagons are returned to the factory.

The road vehicles are loaded from the silos by gravity, the weight of cement

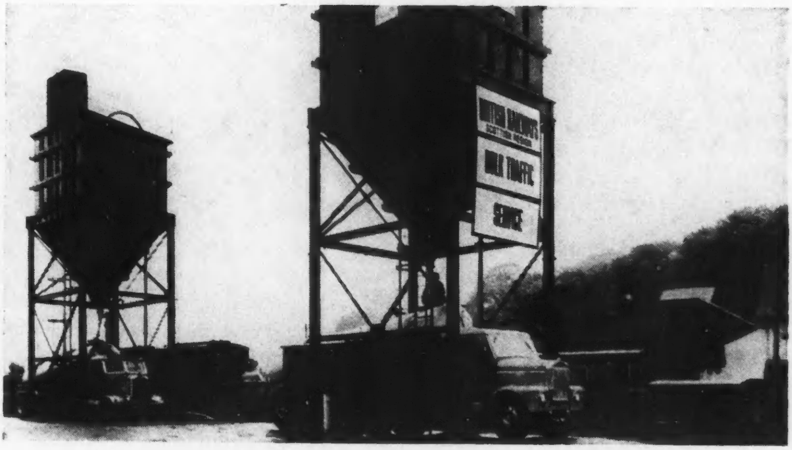


Fig. 1.—Storage Silos.

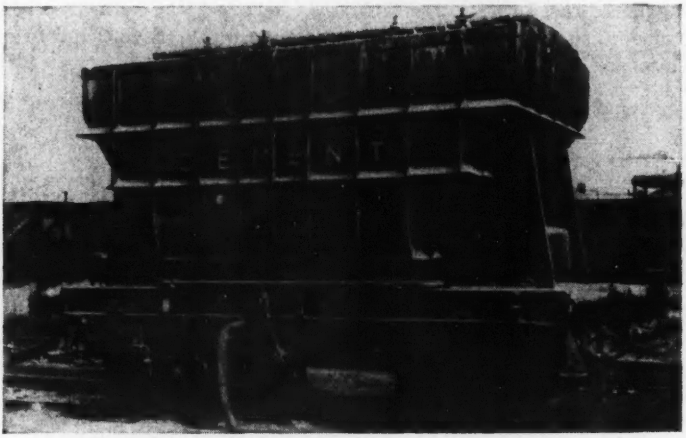


Fig. 2. Railway Wagon for Loose Cement.

in each vehicle being measured by means of an optical-projection weighbridge with a capacity of 28 tons, situated under one of the silos. At the site the vehicles are emptied by means of compressed air. It has been found that this method of discharge causes less dust than occurs when cement is emptied from bags.

The silos are so designed that they can be dismantled and re-erected elsewhere when the power station has been completed.

The Cement Industry in Switzerland.

Cement consumption in Switzerland decreased considerably during 1958, mainly because there was less constructional work. Sales during the first ten months were 1,883,328 tons, a reduction of 15·6 per cent. Sales for the whole year are provisionally estimated to be 2,100,000 tons. The proportion of cement delivered loose was unchanged at about 46 per cent. of total deliveries. By the end of September the proportion of the production exported was 0·5 per cent. and imports, which were mainly of special types of cement, were 0·9 per cent. During the year the production of high sulphate-resistant cement was started at two factories.

Cement Works in Jamaica.

A second kiln is now in operation at the works of the Caribbean Cement Co., Ltd., increasing the capacity to 200,000 tons a year. The installation of a third kiln is being considered.

New Cement Works in Iceland.

A cement works at Akranes has started production; the estimated capacity is 75,000 tons a year, and it is hoped that 100,000 tons a year will be produced.

The Performance of a Grinding Mill.

AN account of the performance of a grinding mill which had produced nearly 350,000 tons of cement with a surface area of 1700 sq. cm. per gramme is given by Mr. J. M. Wolfe and Mr. B. E. Kester (chief engineer and research chemist respectively of the Missouri Portland Cement Co., in one of whose works the machine was installed in the year 1956) in a recent number of "Pit and Quarry". The rate of grinding is 37·5 tons per hour; the power consumption is 35 kWh. per ton.

The mill is 32 ft. long and 10 ft. in diameter and has two compartments. This diameter is sufficient to allow adequate impact grinding, particularly in the first compartment, and the length allows high attrition grinding with subsequently low circulating loads on a closed-circuit system. The first compartment (8 ft. long) is charged with 65,000 lb. of copper molybdenum forged steel balls from 2 in. to 3 in. diameter and has deeply-recessed lifting bars; this gives good reduction by impact of the $\frac{5}{8}$-in. material to an average of 20-mesh material

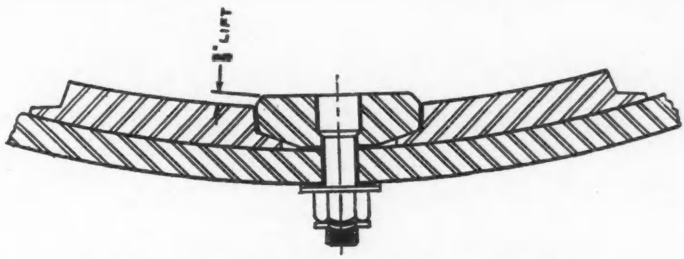


Fig. 1.—Part Cross Section of Second Compartment.

for the second compartment. The second compartment (22 ft. long) is charged with 175,000 lb. of 1-in. NiHard balls and shallow lifting bars and gives efficient reduction by attrition to the desired surface area.

The mill is close-circuited with a 16-ft. air separator and is operated with a normal circulating load of 150 per cent. As only one separator is used, the high production rate of which this mill is capable necessitates the circulating load being low in order to avoid circulating partially-ground clinker through the elevators, conveyors, and air separators, as is done in high-circulating systems. The clinker delivered to the mill has a maximum size of $\frac{5}{8}$ in., so that there is no need for balls larger than 3 in.; the smaller size of the balls contributes to the efficiency. Since the first compartment is short, it serves only to reduce the clinker down to 20 mesh or other desirable size for the 1-in. media in the second compartment. The balls suffer little loss of weight or shape due to wear.

The shallow lifting bars used in the second compartment have contributed to its efficiency. In earlier mills conventional liners with deeply recessed $1\frac{5}{8}$-in. lifting bars were used, with consequent risk of noise, excessive heat, and undue wear

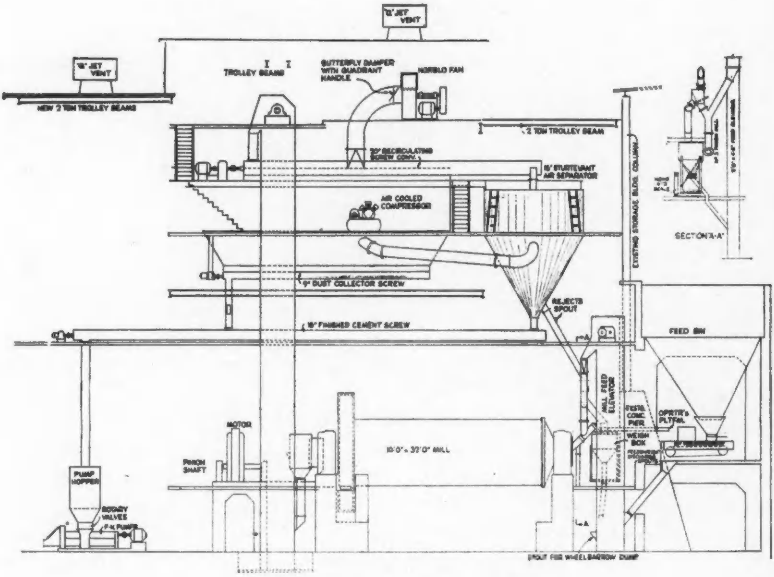


Fig. 2.—General Arrangement.

and breakage of the balls. In this mill the lifting bars are only $\frac{5}{8}$ in. high (*Fig.* 1). The low lifting bars have proved to be very satisfactory. The mill operates quietly, does not overheat as much as the others, and produces more cement per kilowatt of electricity used. It is believed that the conventional lifting bars crash through the charge of balls, raise them too high, and throw them about the mill with undesirable velocity, resulting in generation of heat, waste of power, and wear of metal.

The steel plate shell of the mill is $1\frac{3}{4}$ in. thick, constructed of three plates welded together longitudinally without circumferential joints. The partition head of the first compartment has $\frac{5}{8}$-in. slotted holes at the feed-end side and 2-in. thick solid NiHard plates at the other side. The discharge grate from the second compartment has slotted holes $\frac{1}{2}$ in. wide. The mill heads, with integral trunnions, are thick medium-carbon steel castings, and the heads are reinforced with twelve radial ribs. The casting, heat-treating, and machining of the heads resulted in exceptional freedom from stresses, and they may be expected to operate for a long period without further attention, as should the shell, due to the absence of circumferential joints.

The helical gear, 17 ft. 6 in. in diameter and 27 in. over the face, is a medium steel casting of triangular cross section bolted to a flanged extension of the discharge end head. There are 320 teeth in the gear and 33 in the pinion, and the mill rotates at 18·57 revolutions per minute. A floating shaft, equipped with

two piloted couplings, connects the drive to the shaft of a 1500 h.p., 180 r.p.m. synchronous motor. The clinker is delivered to the mill by a spout, and the inside of the trunnion includes dipping devices which prevent spilling. The mill is under negative pressure from a dust collector and emits very little dust.

The relationship of the mill and its accessory equipment is shown in *Fig.* 2. Some features of the arrangement and design are as follows: (1) A vertical bucket-elevator raises the material from the automatic proportioning devices to the spout. (2) The material from the air-separator falls by gravity, joining the new material just above the spout. (3) By means of a diversion gate, a weigher for measuring the circulating load can receive the material from the air separator. After weighing, the contents of the weighing box pass to the elevator. (4) The working areas are clear and the equipment is accessible for inspection. (5) The building is ventilated by two motor-driven fans in the roof, each with a capacity of 40,000 cu. ft. per minute.

The grinding circuit and the accessory equipment were designed for an output of 45 tons per hour of ordinary Portland cement. The elevator can lift 75 tons of material per hour. The circulating elevator can deal with 500 per cent. circulating load with the buckets at water-level full. The capacity of the 20-in. screw conveyor which delivers the product of the mill to the air separator is 250 tons per hour at 65 revolutions per minute. The fan of the bag-type dust-collector is rated at 23,500 cu. ft. per minute and is capable of drawing 16,000 cu. ft. of air per minute through the air separator for cooling the material, 4500 cu. ft. per minute through the mill for ventilation, and 3000 cu. ft. per minute for suppressing dust at transfer points.

During the first year of operation the mill produced over 250,000 tons of cement including rapid-hardening cement and masonry cement. Production of high-early-strength cement requires changing the number of blades in the air separator from twenty (used for ordinary cement) to the full number of sixty. This change permits the production of rapid-hardening cement at the rate of 20 tons per hour with a Wagner surface area of 2800 sq. cm. per gramme. The overall power consumption of the mill and auxiliaries is under 72 kWh. per ton for rapid-hardening cement. With the maximum number of selector blades on the air separator the circulating load increases to about 400 per cent.

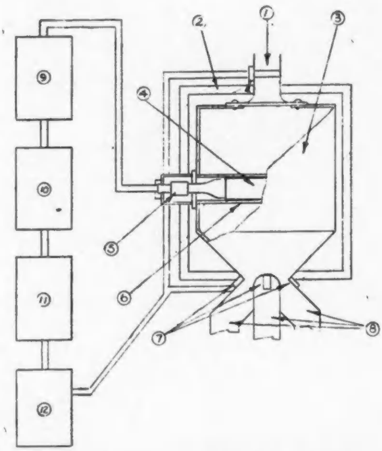
The production of masonry cement requires no change in the number of selector blades in the air separator. A third weighing device adds the required proportion of limestone. In producing masonry cement, a total rate of feed of 34 tons per hour is maintained. With the twenty selector blades used for ordinary cement and only an adjustment of air valves on the air separator, the product has a Blaine surface area of from 5500 to 6000 sq. cm. per gramme. In this case a circulating load of less than 100 per cent. is normal. The overall power consumption of the mill and all the auxiliaries is under 44 kWh. per ton.

During 80 per cent. of the operating time the mill produces ordinary cement. After producing nearly 350,000 tons of cement, there is less than $\frac{1}{8}$ in. wear at the edges of the lifting bars.

Potassium from Cement Dust.

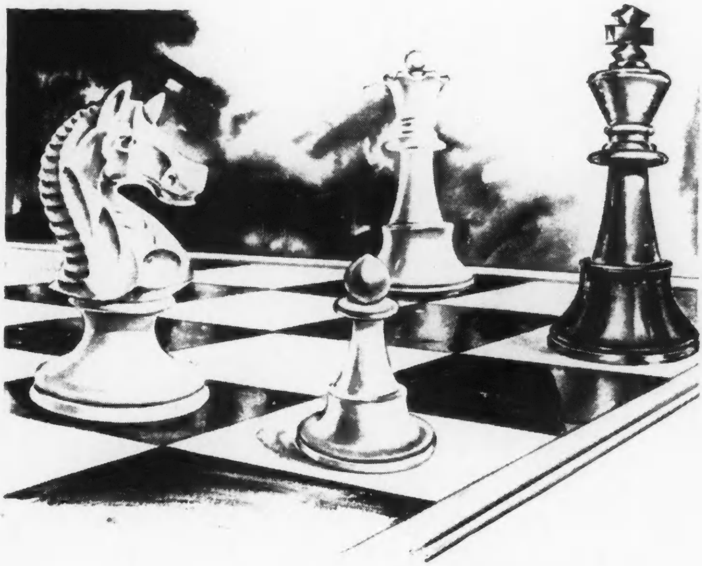
An "industrial tracer" process has been applied to the grading of cement dust at a cement works at Turku, Finland, where some 30 tons of potassium bearing dust particles are recovered every 24 hours from the exhaust-gases of two kilns by means of electric filters. Half of this material is recirculated through the kilns; the other 15 tons contains sufficient potassium to be sold as a fertiliser. The potassium content varies from 7·4 per cent. to 17·3 per cent.

The measuring system (*Fig.* 1) in use is based on the radio-activity of natural potassium and detects and controls the potassium content while the dust is continuously flowing. The process is being developed in this country by Nuclear Enterprises (G.B.), Ltd., of Edinburgh.



1.—Inlet pipe. 2.—Soft iron shield. 3.—Gradation chamber. 4.—Plastic phosphor. 5.—Pre-amplifier and tube assembly. 6.—Detector tube assembly. 7.—Automatic valve switches. 8.—Outlet pipes. 9.—N.E.5202 amplifier. 10.—N.E. differential discriminator. 11.—Scaler with provision for automatic count registration. 12.—Programme controller.

Fig. 1.



Published by CONCRETE PUBLICATIONS, LTD., 14, Dartmouth Street, London, S.W.1, England.
Printed in Great Britain by CORNWALL PRESS LTD., 1-6, Paris Garden, Stamford Street, London, S.E.1